

# HOW MUCH AIR CAN YOU BREATHE? <sup>1</sup>

**Grade Levels:** 4-6

**Time:** 50-60 minutes

## **Purpose**

To help students determine their approximate lung (vital) capacities and demonstrate that different people have different lung capacities.

This lesson is a starting point for future lessons on human respiration and health, and the effects of air pollution on lung capacity.

## **Background**

Air is important to animals for various reasons. The primary importance of air to animals is that it contains oxygen, an essential substance for living. Oxygen is essential because it is used in processes at the cellular level to provide energy for growing and carrying on life's activities.

The vital capacity of the lungs is the maximum volume of air that can be held in the lungs at one time. Vital capacity is important because the more volume of air the lungs can hold, the more oxygen is available to provide energy and carry on various levels of sustained physical activity. Vital capacity can be affected by health conditions (such as asthma and emphysema) and by various types of air pollutants.

## **Objectives**

Students will:

1. Predict their vital capacities.
2. Measure their vital capacities.
3. Graph the vital capacity of each student in the class.
4. Calculate the average vital capacity of the class.
5. List four factors that can affect the vital capacity of a person.

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<sup>1</sup> Adapted from Air and Waste Management Association, Environmental Resource Guide-Air Quality, Grades 3-5, "As I Live and Breathe" Activity, Pg. 55-68, 1996.

## Materials

- 1 gallon (3.78 liter) plastic bottle with a cap
- 500 milliliter (0.5 liter) plastic bottle
- 1 liter plastic bottle
- 1.5 liter plastic bottle
- 2 liter plastic bottle
- 12 X 15 X 6 inch glass or clear plastic pan (or similar size pan)
- 36 inch flexible rubber tubing having the same diameter as a standard drinking straw
- 1 standard drinking straw per student
- 500 ml graduated cylinder
- Water
- Masking tape
- Pencil or waterproof pen
- Overhead projector and marker
- Vital Capacity Summary Sheet (included)
- Graph paper
- Worksheet-How Much Air Can You Breathe? (included)
- Chalkboard

## Preparation

1. Put about 3-4 inches of water into the pan.
2. Place a vertical strip of masking tape that extends from the bottom to the top of the 1 gallon bottle. Use the graduated cylinder and fill the bottle with water at 250 milliliter (ml) increments. Mark and write the accumulated volume on the masking tape at each 250 ml increment (this will aid in the determination of the volume of displaced water).
3. Unscrew the cap, fill the bottle completely with water, and screw the cap back on.
4. Write students' names on the Vital Capacity Summary Sheet, and make an overhead for yourself and a hardcopy for each student.

## Activity

1. Ask students how long they think they can live without the following substances: (a) food (*weeks*), (b) water (*days*), and (c) air (*minutes*).
2. Ask students to take as deep a breath as possible and try to hold the air in their lungs for 30 seconds. After 30 seconds, ensure that all students are breathing normally again. Ask students what can happen if they couldn't breathe for an additional 5-6 minutes. (*They would lose consciousness and die. Therefore, air is the most essential substance needed for immediate survival*).
3. Explain that air is important because it contains oxygen and that oxygen is essential because it is used in processes at the cellular level to provide energy for growing and carrying on life's activities.

4. Explain that not only is breathing air important, but being able to breathe a large amount of air during an activity such as exercising is also important. Also explain the following: (1) the maximum volume of air their lungs can hold at one time is called the “vital capacity,” and (2) vital capacity can be affected by health conditions such as asthma and emphysema, and air pollutants such as dust, smoke, ash, soot, smog, and carbon monoxide. Write the definition for vital capacity on the chalkboard.
5. Display the 500 ml, 1 liter, 1.5 liter, and 2 liter bottles. Ask students to use the bottles as a guide to predict their vital capacity. Display the overhead and hand out hardcopies of the Vital Capacity Summary Sheet. Ask them to share their prediction with the class and write it beside their name on the Vital Capacity Summary Sheet.
6. Write each student’s predicted value by his/her name on the overhead sheet.
7. Explain that in this activity they will determine their approximate vital capacity.
8. Take the water-filled bottle and turn it upside down. Place it in the pan such that the mouth of the bottle is submerged in water (refer to the diagram below).



9. Tip the bottle slightly to the side, remove the cap, and insert one end of the tube into the opening of the bottle. Insert a straw into the other end of the tube. If necessary, tape the straw-tube connection to prevent the straw from sliding out or air from leaking out when air is blown into the straw.
10. Hold the bottle as vertical as possible while a student takes a deep breath and blows into the straw, emptying the air from his/her lungs as completely as possible. **IMPORTANT: FOR HEALTH REASONS, ENSURE THAT EACH STUDENT HAS HIS/HER OWN STRAW TO USE. DISPOSE EACH STRAW AFTER USE.**

11. Mark the water level on the masking tape with a pencil or waterproof pen. If applicable, use the predetermined graduations on the masking tape to estimate the amount of water displaced. Otherwise, empty the water from the bottle into the sink, turn it right side up, and use the graduated cylinder to measure the amount of water needed to fill the bottle up to the mark on the masking tape. Reiterate to students that this is the “vital capacity” of the lungs. (There are also about 25% of residual or “dead” air still left in the lungs which cannot be expelled.)
12. Have each student write his/her sex, age, predicted vital capacity, and measured vital capacity on the overhead and on his/her own Summary Sheet. Have students copy the appropriate data from the overhead onto their Summary Sheet.
13. Have each student repeat the appropriate steps above until every student has completed the activity.
14. Hand out graph paper and have students make a bar graph showing student number (i.e., #1, #2, #3, etc., taken from the Vital Capacity Summary Sheet) on the X-axis and the measured volume on the Y-axis.
15. Hand out the Worksheet and have students complete it.

### **Student Understanding and Reflection**

1. Discuss questions on the worksheet and solicit student responses.
2. Have students reflect on their learning:
  - (a) I discovered that...
  - (b) I was surprised to learn that...
  - (c) The vital capacity is...
  - (d) Oxygen is important to humans because...
  - (e) Some of the factors that can affect vital capacity are...

### **Wrap Up**

Discuss with students the reasons why breathing air to maintain normal body functions is important. *(Air contains oxygen. It is essential because it is used in processes at the cellular level to provide energy and for growing and carrying life’s activities. Among many other things, oxygen helps keep the brain alive, helps keep muscles working, and helps the body make new tissue for growth.)*

Discuss with students why different people have different vital capacities. *(Some of the differences may be due to sex, age, weight, height, and health.)*

Finally, discuss with students different factors that can affect vital capacity *(Some of the factors are health conditions such as asthma and emphysema, and air pollutants such as smoke, ash, dust, soot, and carbon monoxide.)*

**California Science Content Standards, K-12 (Adopted 1998)**

Concepts of the lesson may be connected to the grade-specific content standards below:

**Grade Four**

- 6b. Measure and estimate the weight, length, or volume of objects.
- 6e. Construct and interpret graphs from measurements.

**Grade Five**

- 6f. Select appropriate tools (e.g., thermometers, meter sticks, balances, and graduated cylinders) and make quantitative measurements.
- 6g. Record data by using appropriate graphic representations (including charts, graphs, and labeled diagrams) and make inferences based on those data.

**Grade Six**

- 7b. Select and use appropriate tools and technology (including calculators, computers, balances, spring scales, microscopes, and binoculars) to perform tests, collect data, and display data.
- 7c. Construct appropriate graphs from data and develop qualitative statements about the relationships between variables.

### Vital Capacity Summary Sheet

Name\_\_\_\_\_

DATE\_\_\_\_\_

NAME	SEX	AGE	PREDICTED (ML)	MEASURED (ML)
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				
19.				
20.				

## Worksheet: How Much Air Can You Breathe?

Name \_\_\_\_\_ Date \_\_\_\_\_

1. What is your predicted vital capacity? \_\_\_\_\_
2. What is your measured vital capacity? \_\_\_\_\_
2. Calculate the average measured vital capacity in your class. (Hint: Add up all the measured volumes and divide this number by the number of students who participated.)

Average measured vital capacity \_\_\_\_\_

3. How many boys and girls have measured vital capacities above the average?  
 Number of boys \_\_\_\_\_ Number of girls \_\_\_\_\_
4. How many boys and girls have measured vital capacities below the average?  
 Number of boys \_\_\_\_\_ Number of girls \_\_\_\_\_
5. Is there a big difference in the measured vital capacities between the boys and girls in your class? \_\_\_\_\_ Why or why not?

6. Explain why a person's vital capacity does not stay the same throughout his/her life.

7. List four factors that can affect the vital capacity of a person.

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_____	_____